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AUTHOR Britt, Yvette Daniel; Feldman, David
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ABSTRACT

The study investigated whether the pre-arrangement of math facts in spaced repetitions redundancy would increase the acquisition rate of a second grader with poor mathematics achievement. Baseline data were provided by observation of in-class math performance of addition sums zero through 18. In the experimental phase, worksheet problems were presented visually and arranged in 50% spaced redundancy and the subject was reinforced for correct responses. Subsequent intervention phases used only reinforcement and spaced redundancy and then only spaced redundancy. During the intervention phases, the S's error rate dropped to near zero, with long term retentive learning demonstrated. Results suggested that 50% spaced redundancy was a powerful antecedent stimulus in remediating math deficiencies. (CL)

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The Effect of Redundancy on Accelerating Academic Performance in Math of a Primary Grade Learning Handicapped Student

A Paper Presented at the
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Yvette Daniel Britt
David Feldman
Department of Communicative Disorders and Special Education
The University of Tulsa

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David Feldman, Ph.D., is an assistant professor in the Division of Communicative Disorders and Special Education at The University of Tulsa, Tulsa, Oklahoma.

Yvette Daniel Britt, M.A., is a graduate student in the Division of Communicative Disorders and Special Education at The University of Tulsa, Tulsa, Oklahoma.

ABSTRACT

This study investigated the practical application of Spitz's Input Organization Theory (1966, 1973) on a second grade student's ability to accurately remember his mathematics addition facts, sums zero to 18. The results clearly demonstrated that the antecedent efforts of the teacher to preorganize addition facts learning through spaced repetition significantly influenced the student's math accuracy and long term retention behavior.

Several studies have demonstrated that operant procedures increase math performance accuracy in elementary age students (e.g., Harris & Sherman, 1973; Hasazi & Hasazi, 1972; Kirby & Shields, 1972; Lovitt & Curtiss, 1968). Lovitt and Curtiss (1968) produced positive increases in academic response rate as a result of student verbalizing in addition to writing correct answers and self-imposed as opposed to teacher-imposed reinforcement contingencies. Kirby and Shields (1972) utilized an adjusting fixed-ratio schedule of verbal praise and immediate corrective feedback to significantly influence academic task accuracy while Harris and Sherman (1973) described a structured program of peer-tutoring procedures which produced a positive, accelerated effect on math performance. In the Hasazi and Hasazi (1972) study, results clearly indicated that the student's appropriate digit-ordering behavior was under the stimulus control of teacher attention. These studies, although successful in changing academic behavior, were limited to manipulating reinforcement contingencies and other consequent events as opposed to manipulating possible antecedent stimuli (e.g., teaching mnemonic strategies).

Increasing attention has been focused on developmental differences between the mentally retarded and nonretarded and their relationship to the utilization of organizational and mnemonic procedures to assist the student's recall accuracy (e.g., Jacobs & Foshee, 1971; Lebrato & Ellis, 1974; Spitz, 1972). Spitz (1966, 1973) postulated in his Input Organization Theory that learning handicapped individuals would require additional assistance beyond instructional efforts to teach various mnemonic strategies to the mentally retarded learner in order to recall academic material. Spitz's theory suggested that learner recall could be significantly influenced by systematic efforts to preorganize visual academic stimuli (Mercer & Snell, 1977). In 1972, Spitz, Goettler, and Webreck presented a series of experiments which were designed to

further understanding of the processes involved in effectively organizing visual material for recall. Specifically, Spitz, Goettler, and Webreck were interested in utilizing redundancy (i.e., stimuli that contain repetitive common elements) in combination with a digit span task. One aspect of their study concentrated on the differential effects of two types of visual schematic redundancy; couplet redundancy (e.g., 4,4,1,1,8,8,6,6) and repetition redundancy (e.g., 4,1,8,6,4,2,8,6). Couplet redundant stimuli were found to be more easily recalled than that repetition redundant stimuli. However, a clear limitation to the investigations of Spitz and his associates (1972) was the absence of utilitizing mnemonic preorganization strategies with academically deficient learners in applied settings (e.g., the school classroom).

The present study attempted, in the regular classroom under typical classroom conditions (e.g., large group instruction; n 30), to determine if the prearrangement of math facts in spaced repetitious redundancy, i.e., ABACAD (Feldman, 1979), would positively accelerate the acquisition rate of a remedial student's academic performance on math facts for addition sums zero through 18.

METHOD

Subject and Setting

The subject was a second grader who was rated by his classroom teacher as the poorest achieving math student in the classroom. The subject was an eight-year-old male attending a public school in a socioeconomic middle class neighborhood. His math score on the SRA Achievement Test at the end of his first grade year was 0.07. In class, he seldom operated above the chance level of probability on his math problem solving assignments.

Target and Behavioral Measures

The target behavior was to increase the subject's accuracy on written responses to visually presented math facts problems for addition sums zero to 18. An independent observer was used to record the subject's accuracy on

math performance during math sessions conducted with the entire class. The observer was seated in the back of the classroom, at the right of the subject's desk. The observer recorded the permanent product accuracy (i.e., number of problems correct and incorrect the total number of assigned problems) of the subject's regular math assignments. In addition to these procedures, the observer and the classroom teacher maintained a continuous account of the subject's accuracy on each individual fact for addition sums zero through 18 to determine acquisition rate. The teacher and observer were 100% in agreement on scoring the accuracy of the subject's worksheet responses.

Procedure

During this phase the teacher conducted each math session in a normal fashion. On a daily basis for one week, the subject was given worksheets to compute containing the sums zero through 18. Worksheets were arranged in order of increasing complexity. Overall, he was given seven worksheets. The first worksheet contained the addend zero added to the number, one through nine, as well as the reversals (e.g., 0+1=, 1+0=). Each worksheet varied in number of problems according to the number of problems for each addend. No problems were repeated on any worksheet nor was verbal reinforcement provided to the subject. Worksheets for the sets of zero through 18 were individually identified and given to the subject according to the following sequence:

Worksheet	Addend Involved
1a	0
2b	1
3c	2
4d	3
5e	4
6f	5
7g	6
8h	7
9i	8
10j	9

Prior to the experimental phase, the teacher made up a list of classroom

reinforcers and also gave the subject a reinforcement survey. From these data, the teacher constructed a contract and a reinforcement menu based on the number of problems worked correctly.

Since the subject made no errors on worksheet 1, he was introduced to a problem he had done incorrectly on the second worksheet to commence the first intervention phase. The teacher demonstrated the problem by adding the two numbers with representative wooden blocks. Then the subject was given a worksheet of 10 problems. The problems on the sheet were arranged in 50% spaced redundancy, i.e., ABACAD, (Feldman, 1980). "A" was the new problem to be learned while B, C, and D were review problems from worksheet 1. The student was allowed to use the blocks if necessary. In addition, he was reinforced from the menu by choosing his reward based on the number of correct problems.

The teacher then returned to baseline. The conditions of visual cues (i.e., blocks), redundancy, and reinforcement were withdrawn.

In the second intervention phase, the teacher introduced the same problems appearing in the first intervention phase. The subject was given a worksheet of 10 problems arranged in the spaced redundancy format. This time the blocks were withdrawn but the student was still reinforced for all correct answers.

During the third intervention phase the teacher presented the problems with spaced redundancy without the utilization of concrete visual cues or reinforcement. At the conclusion of this phase, the teacher again returned to baseline conditions.

RESULTS

During the first baseline condition, the subject's average math facts accuracy was 59% over 10 worksheets. His range of math accuracy varied from 19 correct out of 19 (i.e., worksheet 1A) to zero correct out of a possible eight problems (i.e., worksheet 7G). For the first intervention phase (i.e., blocks, redundancy, and reinforcement) his accuracy increased on the 10 worksheets to a mean of 98.5%. This increase over the previous baseline was

9.5%. A second return to baseline conditions produced a 0.5% decrease in accuracy from the first intervention phase (i.e., 98.5% to 98%). In the second intervention phase (i.e., redundancy and reinforcement), mean accuracy reached 99% which was a 40% increase in accuracy over the first baseline condition. During the third intervention phase (i.e., redundancy alone), accuracy reached 100% on each of the 10 worksheets. Mean accuracy, upon return to the final baseline conditions, was maintained at the 99% level. Figure 1 presents the six phases of the study and the subject's math accuracy for addition sums zero to 18 in relation to the total number of problems given, number of problems right, number of redundant problems right, and number of problems wrong across the 10 worksheets.

Place Figure 1 about here

DISCUSSION

Throughout the experimental phases of the study, the subject's pattern of responding to the preorganized mathematics stimuli was relatively consistent. During baseline 1, when he simply worked the problems without antecedent or consequent interventions, his correct responses were only marginally higher than his erroneous responses. During intervention phase 1, phase 2, and phase 3, his error rate dropped to near zero and remained there. Long term retentive learning was clearly demonstrated as accuracy was maintained during each return to baseline. The redundant problems presented during the experimental phases of the study were never worked incorrectly by the subject. The significant results suggest that 50% spaced redundancy was a powerful antecedent stimulus in remediating the targeted math deficiencies.

However, these results may be due to the possibility that the subject's utilization of the blocks may have helped him visually and repetitively practice the problems prior to attempting to solve the same problems with

redundancy alone. In addition, the reinforcement survey and menu were possibly highly motivating for the subject. Another plausible consideration could be that directed teacher attention was reinforcing to the subject. The preorganized efforts led to immediate and relatively permanent positive results. Success is powerful reinforcement. Future research should attempt to introduce each intervention in isolation so that multiple influences can be partialed out as possible experimental confounds. The results of the 50% spaced redundancy procedure were positive but additional comparative research is needed to test the benefits of high redundancy conditions (i.e., 50% to 75%) against lower redundancy levels, as well as the effects of spaced redundancy (e.g., ABCADE) versus massed redundancy (e.g., ABCCCD) on retentive ability. Once these research directions have been undertaken and accomplished, tangential research inquiries into the effects of massed repetition redundancy (e.g., ABCCCD/ABCCCD) and spaced repetition redundancy (e.g., ACBCDC/ACBCDC) on memory could produce valuable insights into the antecedent potency of input organizational procedures.

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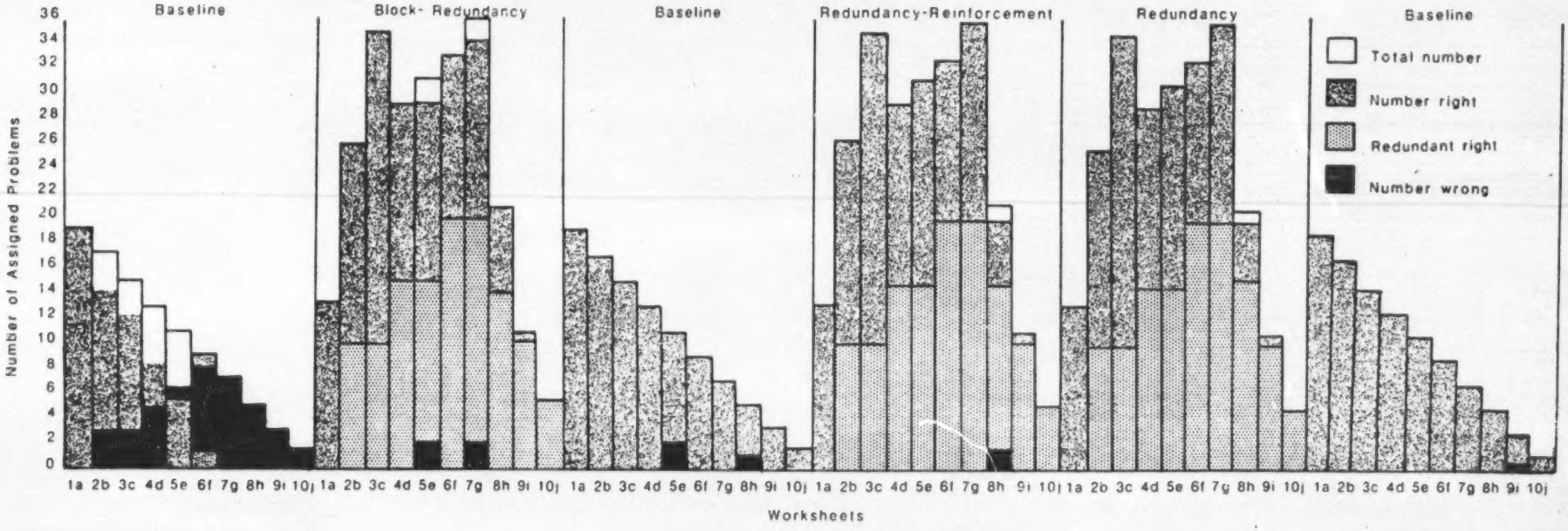

Figure 1. The number of assigned math problems over the worksheets sequence. Accuracy results accross the five experimental conditions.